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# Development, validation and reliability of the Chrononutrition Profile - Questionnaire

**Allison C. Veronda, M.S.**[1], **Kelly C. Allison, Ph.D.**[2], **Ross D. Crosby, Ph.D.**[3,4], **Leah A. Irish, Ph.D.**[1,3]

[1]Department of Psychology, North Dakota State University, Fargo, ND, United States

[2]Department of Psychiatry, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, United States

[3]Sanford Center for Biobehavioral Research, Sanford Research, Fargo, ND, United States

[4]Department of Psychiatry and Behavioral Science, University of North Dakota School of Medicine and Health Sciences, Fargo, ND, United States

## Abstract

Chrononutrition, or the circadian timing of food intake, has garnered attention as a topic of study due to its associations with health (e.g., weight gain); however, a valid and reliable assessment of chrononutrition in daily life has not yet been developed. This paper details the development and initial reliability and validity testing of the Chrononutrition Profile – Questionnaire (CP-Q). The CP-Q assesses 6 components of chrononutrition that are likely to influence health (breakfast skipping, largest meal, evening eating, evening latency, night eating, and eating window). This questionnaire is designed to assess general chrononutrition behaviors and preferred timing of food intake. The CP-Q can be used as a sole evaluation of chrononutrition, and can also be utilized in conjunction with existing dietary measures to provide a comprehensive assessment of one's eating behaviors. This measure offers health care professionals, researchers, and stakeholders a cost-effective and comprehensive method of evaluating chrononutrition and identifying targets for health improvement.

### Keywords

chrononutrition; eating behaviors; timing of food intake; reliability; validity; development

## Introduction

Approximately 70% of United States adults have overweight or obesity (Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016). This excess weight puts individuals at increased risk

Correspondence concerning this article should be addressed to Allison C. Veronda, Dept. 2765, P.O. Box 6050, Fargo, ND, 58108-6050. Phone: 309-574-0449. allison.veronda@ndsu.edu.

Disclosure of Interest

RDC is a paid statistical consultant for Health Outcomes Solutions, Winter Park, Florida. KCA was a consultant for WW (formerly Weight Watchers, International) within the past two years. ACV and LAI report no conflict of interest.

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for serious comorbidities, including type 2 diabetes (Eckel et al., 2011) and cardiovascular disease (Ortega, Lavie, & Blair, 2016). Many efforts aimed at overweight and obesity prevention and treatment target the quality and quantity of one's dietary intake, but individuals may have difficulty following such guidelines long-term (Kraschnewski et al., 2013). Recent research in the field of circadian science has suggested that *when* food intake occurs may also play a role in markers of health, in addition to *what* and *how much* is eaten. Specifically, evidence suggests that chrononutrition, defined as the circadian timing of food intake (Arble, Bass, Laposky, Vitaterna, & Turek, 2009), is related to weight (e.g., Arble et al., 2009), and weight-related health outcomes such as insulin resistance (Chaix Zarrinpar, Miu, & Panda, 2014), metabolic disease (e.g., Hatori et al., 2012), and inflammation (e.g., Chaix, et al., 2014) (for reviews, see Asher & Sassone-Corsi (2015) and Eckel-Mahan & Sassone-Corsi (2013)).

Thus, chrononutrition may provide innovative avenues for health and weight management which are distinct from traditional dietary approaches. Laboratory work has clearly demonstrated independent effects of chrononutrition and dietary intake. Studies in nocturnal mice have shown that restricting food access to only waking hours can protect against the negative health effects of a high fat diet (Hatori et al., 2012). Mice with ad libitum access to high-fat food gained almost 30% more weight, had a greater percentage of body fat, and had increased inflammation compared to mice with restricted food access. Remarkably, calorie intake was equivalent across study conditions. Similar findings have been reported in a pilot study of humans by Gill and Panda (2015): individuals who reduced their eating window from 14 h/day to 10–12 h/day lost weight, reported greater subjective energy and improved sleep satisfaction, and were able to adhere to this behavior change for 36 weeks. This restriction of the eating window also led to decreased caloric intake. Because many individuals are unsuccessful at changing what and how much they are eating, such findings suggest that modifying when they eat may be a promising avenue for weight and health behavior interventions.

Recent experimental work examining the circadian timing of food intake in humans and animals has provided valuable insight into the importance of appropriate timing of eating. Simply altering the timing of food intake to an inappropriate time, such as feeding during the typical sleep time rather than during the typical wake time, has led to increased body weight in mice - even when calorie intake is identical across conditions (Arble et al., 2009). Relatedly, a restricted eating window (e.g., 8 h/day window) can minimize negative effects of an unhealthy diet - such as weight gain, inflammation, and insulin resistance - in both mice (Chaix, Zarrinpar, Miu, & Panda, 2014) and humans (Gill & Panda, 2015). Proper timing of feeding/fasting in relation to the body's energy needs can enhance metabolic health (for review, see Potter, Cade, Grant, & Hardie, 2016), while inappropriate timing of feeding has been associated with impaired physical and mental health (for review, see Reid, Baron, & Zee, 2014). This is likely due to the vital role of the feeding/fasting cycle in entraining the body's liver clock to the 24-hour day (Johnston, 2014); consequently, engaging in certain behaviors (e.g., eating) at the "wrong" time of day can misalign the phase of an individual's circadian rhythm and negatively influence health (for review, see Eckel-Mahan & Sassone-Corsi, 2013).

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In addition to chrononutrition behaviors, chrononutrition preferences (i.e., when one *prefers* to eat) are another area of chrononutrition which should be considered. Related chronobiological constructs such as chronotype incorporate sleep/wake timing preferences as well as sleep behaviors, both of which have been shown to be associated with health behaviors and health outcomes (e.g., Baron, Reid, Kern, & Zee, 2011; Paine, Gender & Travier, 2006). Similarly, chrononutrition preferences may be important to know, as these are likely to impact adherence to certain eating schedules, as well as health behavior and lifestyle changes.

A thorough review of current literature was conducted to 1) evaluate existing measures and assess the need for a measure of chrononutrition, and 2) identify domains of relevance for the construct of chrononutrition.

Existing dietary and sleep assessments were reviewed to evaluate the need for a measure of chrononutrition. The majority of self-report dietary assessments do not include questions about the timing of food intake (e.g., Rapid Eating Assessment for Patients (REAP; Gans et al., 2003); Food Frequency Questionnaire (Willett et al., 1985)). A few comprehensive, daily dietary recall assessments do include information about the timing of caloric intake. These assessments may be quite burdensome for participants (e.g., Automated Self-Administered 24-hour dietary recall (ASA24); Subar et al., 2012) or researchers (e.g., interviewer-administered 24-hour dietary recall; Thompson & Subar, 2012) to complete. Furthermore, these assessment methods are prone to under-reporting of caloric intake (Kye et al., 2014), potentially due to the lengthy duration of daily completion. In addition, one questionnaire (Meal Pattern Questionnaire, Bertéus, Lindroos, Sjöström, & Lissner, 2002) does assess the typical timing of food intake; however, this measure does not differentiate between eating patterns on work/school days and free day. This may be useful in situations where researchers want to evaluate general eating patterns, but it may not be appropriate in all cases, as eating patterns likely differ on work/school days and free days (Roenneberg et al., 2007). This measure has not been validated against prospective assessments of food timing (Dashti, Scheer, Saxena, & Garaulet, 2019). Another existing measure of food timing, the Eating Pattern Questionnaire (Guirette et al., 2019), allows for assessment of eating events throughout the 24-hour day, but the labels used to measure the frequency with which participants report eating throughout the day (always; sometimes; never) are abstract; interpretations of these phrases may differ between individuals. Such labels could allow researchers and healthcare professionals to quickly obtain a rough estimate of participants' eating behaviors but would limit the sensitivity with which the measure could detect finer distinctions between chrononutrition patterns or changes over time. The reliability of the Eating Pattern Questionnaire has not been determined. Further, neither the Meal Pattern Questionnaire nor the Eating Pattern Questionnaire provide a comprehensive assessment of chrononutrition: these measures do not assess sleep timing, so they do not allow for computation of the duration of time between eating events and sleep, and the utility of these measures in evaluating eating window was not discussed. Though the aforementioned measures provide insight into participants' actual timing of food intake, to our knowledge, no existing assessment measures participants' preferred timing of food intake, though this information may be crucial in the development of eating schedule interventions. Sleep assessments such as the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk,

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Berman, & Kupfer, 1989) measure numerous indicators of sleep quality, including bedtime and wake time, but do not ask participants about the timing of their food intake. In light of the potential health implications of chrononutrition, and the limitations of existing assessment strategies, there is a need for a standardized chrononutrition assessment that minimizes participant burden.

The extant literature provides empirical support for 6 overarching chrononutrition behaviors (i.e., aspects of when one eats) which comprise one's chrononutrition profile and collectively affect overall health (e.g., Gill & Panda, 2015; Kant & Graubard, 2015); see Table 1 for definitions and summary of literature on these chrononutrition behaviors. Breakfast skipping (represented as days per week) is a relevant chrononutrition behavior, likely because of the impact it has on the initiation of the liver clock (Hirao et al., 2010). Largest meal refers to the meal (i.e., breakfast, lunch, dinner/supper) in which participants consumed the greatest amount of calories. Evening eating refers to eating late in the waking day, denoted as a clock time. This construct is relevant for chrononutrition, as the time of this eating event marks the end of the daily feeding/fasting cycle. The duration of time, in minutes, between one's last eating event and sleep onset (i.e., evening latency) is also important to consider. Although the feeding/fasting and sleep/wake cycles run parallel to and do influence one another, these cycles are distinct and should not occur simultaneously. When such overlap does occur, it typically takes the form of night eating. Night eating, a component of night eating syndrome (Stunkard, Grace, & Wolff, 1955; Allison et al., 2010), refers to the number of days per week an individual engages in eating after initial sleep onset. Night eating may result from circadian desynchrony of the sleep/wake and feeding/fasting cycles (O'Reardon et al, 2004). Finally, eating window is typically defined as the duration of time, in minutes, between the first eating event and the last eating event of the day. Taken together, evidence to date has suggested that these behaviors are relevant to chrononutrition, but knowledge is still somewhat limited. These key chrononutrition behaviors have been associated with various negative health outcomes, as previously described, and were included in the initial measures.

Overall, the extant literature supports the need for improved understanding of chrononutrition behaviors and preferences and to evaluate chrononutrition within the context of promoting better health. It is clear chrononutrition is a construct worth measuring; however, a valid and reliable assessment of chrononutrition in the natural environment does not presently exist. Rather than replacing the well-established nutritional guidelines, a chrononutrition assessment could supplement these and provide additional information on individuals' eating patterns, offering a comprehensive approach to nutritional health.

The purpose of the present study was to develop and evaluate the Chrononutrition Profile - Questionnaire (CP-Q). The CP-Q is built upon a foundation of empirical evidence which identifies several behavioral indicators associated with relevant health outcomes. This measure is designed to serve as a thorough yet concise assessment which captures each of these aspects of chrononutrition without imparting significant participant burden. Reliable and valid assessment methods from the fields of nutrition, sleep, and health research were utilized to evaluate and refine the CP-Q.

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## Materials and Methods

The development of the Chrononutrition Profile - Questionnaire (CP-Q) was informed by expert insight, examination of relevant literature and related measures, and one-on-one participant interviews. Validity and reliability of the CP-Q was tested through online surveys. All study procedures and materials were approved by the Institutional Review Board at North Dakota State University.

Based on the literature search of existing measures described above, the CP-Q was designed to complement and extend the assessment capabilities of existing measures. The design of the CP-Q was further guided by a review of existing assessments of chronotype. Although chronotype assessments capture preferences for the timing of sleep and wakefulness and do not typically measure timing of dietary intake, the constructs are conceptually similar and the structure and scoring utilized by chronotype assessments can help inform the development of new chrononutrition assessments. For example, the Munich ChronoType Questionnaire (MCTQ) (Roenneberg et al., 2007) evaluates the phase of synchronization through sleep/wake timing on both free and work days. The assessment of behavior on both workdays and free days was a foundational aspect of the CP-Q development, as individuals commonly report diverse sleep/wake and feeding/fating patterns between workdays and free days. Preference items in the CP-Q are modeled after those in the Composite Scale of Morningness (CSM; Smith, Reilly, & Midkiff, 1989). This literature review indicated that no valid and reliable measure of general chrononutrition exists, so a preliminary draft of a chrononutrition measure was created.

The preliminary 18-item draft of the CP-Q used a combination of open-ended and multiple choice answer options, assessing both chrononutrition preferences and chrononutrition behaviors. Each item was reported on both workdays and free days. Experts in dietetics, eating disorders, circadian rhythms, scale development, and health psychology from North Dakota State University (NDSU) and Sanford Center for Biobehavioral Research in Fargo, North Dakota, were consulted to provide feedback on the preliminary version of the measure. This resulted in minor adjustments to question wording.

To obtain additional qualitative data with regard to participants' experience with the CP-Q, and to address questions that may have arisen while completing the assessment, a sample of NDSU undergraduates completed an in-person interview. Participants (N=20) who completed this in-person interview were primarily female (30% male) and Caucasian (10% racial/ethnic minority), and their age ranged from 18 to 37 years (M = 19.90, SD = 4.38). The principal investigator (AV) interviewed each participant individually in a private room. Participants were given a paper copy of the questionnaire items and asked to read each item aloud and talk through their thought process as they responded to each item. The interviewer would probe for additional clarification or feedback as necessary. The interviews resulted in minor changes and clarifications to wording. After these minor wording changes, this version was used to evaluate reliability and validity.

Chrononutrition Profile – Questionnaire (CP-Q). The CP-Q consists of 18 items designed to evaluate general patterns of chrononutrition preferences and chrononutrition behaviors, on

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typical work/school days and free days. Specifically, we ask about the time of participants' first and last eating events of the day, as well as lunchtime, to allow for assessment of eating window and evening eating. We also ask them to report the time they fall asleep and wake up. Additionally, participants report the frequency with which they engage in certain chrononutrition behaviors (i.e., breakfast skipping, night eating) per week (e.g., "How often do you wake up in the night to eat?"). Further, they are asked to report their typical largest meal ("What is your largest meal of the day?"). Four items are used to assess chrononutrition preferences (e.g., "If you were entirely free to plan your day, how soon after waking up would you prefer to have your first eating event of the day?"). The full version of the CP-Q and detailed scoring algorithms are presented in Appendices A and B.

## Testing Validity and Reliability of the CP-Q

**Participants and procedures.—**We recruited undergraduate students enrolled in psychology courses at North Dakota State University. Study enrollment occurred online through Sona Systems, a form of participant management software maintained by the university's psychology department. Individuals were eligible to enroll in the study if they were at least 18 years old. Participants provided electronic informed consent. Participants were required to have home Internet access through a phone, computer, or tablet to complete the study.

Enrolled participants (N=191) completed an online battery of questionnaires that included the CP-Q, the PSQI (Buysse et al., 1989), and the Night Eating Questionnaire (NEQ; Allison et al., 2008); participants also reported health and sociodemographic information (e.g., age, gender, medical conditions) to allow for assessment of potential covariates. Participants who successfully completed these were sent a link to the ASA24, and were instructed to complete this at bedtime for 3 days. Of the original 191 participants, 149 (78.0%) completed all 3 days. These individuals were sent a request via email two weeks later to repeat the CP-Q taken at baseline in order to evaluate test-retest reliability. A total of 146 participants completed all 3 stages of the study, and this sample was included in the present analyses. Altogether, the final sample completed 467 intervals of the ASA24. Attrition analyses revealed that these participants did not differ on age, gender, or race from participants who withdrew from participating in the study. There were also no meaningful differences in chrononutrition between the individuals who completed the entire study and those who withdrew from the study early.

**Measures.—**As no global, validated measure of chrononutrition was available at the time of CP-Q development, specific items in the ASA24 (Subar et al., 2012), and the PSQI (Buysse et al., 1989), along with NEQ total scores (Allison et al., 2008) were used to examine convergent validity for key continuous variables assessed by the CP. Present analyses focused on the validation of chrononutrition behaviors, as no criterion are currently available to evaluate chrononutrition preferences.

**ASA24.:** The ASA24 Dietary Assessment Tool, developed by the National Cancer Institute, Bethesda, MD, enables researchers to collect Web-based 24-hour dietary recalls (Subar et al., 2012). The ASA24 is modeled after the interviewer-administered Automated Multiple-

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Pass Method, a multi-step approach in which an interviewer first asks the interviewee to list all foods and beverages consumed, interviewees are then guided through a structured process during which they are asked to provide additional details and are given potential memory cues, and finally interviewees are again provided memory cues and are asked to report any other food items (Setinfeldt, Anand, & Murayi, 2013). The ASA24 is a valid and feasible tool for collecting dietary intake data in large samples of both English and Spanish speakers (Kirkpatrick et al., 2014). Participants are first asked to report a meal or snack by selecting a label from a dropdown list ("Select a meal or snack:") and to indicate the time and location of each meal or snack (Subar et al., 2012). Next they are asked to search for the foods and drinks consumed at each meal or snack ("Type in a search term in the box. Search for one food or drink at a time."), and to provide additional details about each food and drink (e.g., "Where did you get this food (or most of the ingredients for it)?") (Subar et al., 2012). Participants also report details such as the portion size and preparation of food (Subar et al., 2012). The assessment does not examine sleep onset/offset relative to meals and snacks, or preferences for the timing of food intake. The timing of food intake and caloric intake from the ASA24 were used for validity estimates in the present study.

**PSQI.:** The PSQI (Buysse et al., 1989) is a self-report assessment of sleep quality complaints over the past month. Participants are asked to report information such as their bed time and wake time, how many minutes it takes them to fall asleep, and their subjective sleep quality. Example items are as follows: "During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed.)" and "During the past month, when have you usually gone to bed at night?" Responses to these are used to compute seven PSQI component scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction). Possible component score values range from 0 (no difficulty) to 3 (severe difficulty). Component scores are then totaled to create a global score, ranging from 0 to 21. A PSQI global score of "0" indicates no difficulty while a score of "21" indicates severe difficulty in each of the seven components of sleep quality. The PSQI has demonstrated good reliability and validity (Carpenter & Andrykowski, 1998; Gelaye et al., 2014; Hinz et al., 2017). Bedtime and wake time values, and sleep onset latency as reported in the PSQI were used for this study.

**NEQ.:** The *NEQ* contains 14 items and is used to assess severity of night eating symptomatology through 4 factors, including "nocturnal ingestions, evening hyperphagia, morning anorexia, and mood/sleep" (Allison et al., 2008, p. 62). Example items include, "Do you need to eat in order to get back to sleep when you awake at night?", "How much of your food intake do you consume *after* suppertime?" and "How much control do you have over your eating while you are up at night?" Items are scored from 0 to 4, with 0 indicating low severity and 4 indicating extreme severity. Thirteen of the 14 items are summed to compute a total score; total scores may range from 0 to 52. Good psychometric properties of this measure have been demonstrated (Allison et al., 2008; Moizé et al., 2012).

In addition, participants were asked to report height and weight to allow for calculation of BMI, as well as their dietary intake patterns via the REAP (Gans et al., 2003), and their

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health-related quality of life through the 36-item Short-Form Health Survey (SF-36; Ware & Sherbourne, 1992). An example REAP item is “In an average week, how often do you eat 4 or more meals from sit down or take out restaurants?”, with response options ranging from Rarely/Never to Usually/Often. An example SF-36 item includes: “In general, would you say your health is” with response options ranging from 1 = Excellent to 5 = Poor. These measures have shown to be reliable and valid (Gans et al., 2003; Brazier et al., 1992; Jenkinson, Wright, & Coulter, 1994; Zhang, Qu, Lun, Guo, & Liu, 2012).

**Preparing the Data for Analysis.—**Because behavior patterns are known to differ for individuals between work days and free days (Roenneberg et al., 2007), we adjusted our calculations to more accurately reflect these patterns. As there were differences in the timing of assessment of the ASA24, three different methods were used to compare values to the CP-Q. If participants only reported free days on the ASA24 (N=5), we only used free day values that were reported in the CP-Q. If participants reported only workday values on the ASA24 (N=70), we used only workday values that were reported in the CP-Q. Finally, if participants reported both free days and workdays in the ASA24 (N=71) we computed a weighted weekly average CP-Q value which included both free day and workday CP-Q values. These steps were taken to ensure that the type of day matched in each assessment, but would not be necessary for protocols using the published CP-Q.

Prior to analyses in which ASA24 values were compared to CP-Q values, ASA24 intervals in which participants reported feeling ill were excluded. This was done because the CP-Q is designed to assess one’s general chrononutrition on a typical day, and illness would indicate that a given interval was not normal. Of the 467 intervals collected via the ASA24, 35 intervals were excluded from CP-Q calculations and analyses due to participant illness.

**Data Analysis.—**Goals for the present analyses included: a) exploring the characteristics of individual items and b) evaluating validity and reliability of the CP-Q.

The CP-Q is designed to assess general chrononutrition patterns over a typical week. Therefore, validity analyses of the CP-Q were focused on this assessment’s weekly average estimate of sleep and eating timing, including bedtime, first eating event, and last eating event. These were used to calculate the key chrononutrition variables of evening latency, evening eating, and eating window. Weekly frequencies of breakfast skipping, largest meal, and night eating were also computed.

To test convergent validity of the CP-Q, Pearson product-moment coefficients were calculated between continuous weekly average CP-Q values and select items from the averaged ASA24 data and the PSQI. Items from the ASA24 data included the first and last reported eating events of the day, and the frequency with which breakfast was not reported (i.e., no eating events were labeled as “breakfast” for that ASA24 interval). These allowed for the calculation of participants’ breakfast skipping frequency, evening latency, evening eating, and eating window. Items from the PSQI included bedtime and sleep onset latency, which allowed for calculation of the time participants fell asleep.

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To evaluate convergent validity of the reported largest meal, we calculated the level of agreement between the largest meal as reported in the CP-Q and the calories reported in the ASA24. To do this, caloric intake of each eating event reported within the ASA24 was first explored to determine the eating event in which the greatest number of calories was consumed. Using the CP-Q data, we then computed a proportion of days for which each eating event was the largest meal (i.e., greatest caloric intake), out of all days of data collection. If participants reported the same largest meal on more than half of days (i.e., more than 50%), this was considered their typical largest meal. If participants did not report the same largest meal on more than 50% of days, they were considered to not have a typical largest meal. Participants' typical largest meal, as reported in the ASA24, was then compared to their largest meal as reported in the CP-Q to determine the level of agreement between these variables.

The intention was to also evaluate convergent validity of night eating using the NEQ; however, night eating was reported at a very low frequency in this sample. Ten participants (6.8%) self-reported waking in the night to eat on at least one night per week in the CP-Q, but zero participants were classified as having night eating syndrome based on their NEQ scores. Because of this low base rate, night eating was not included in the present analyses.

Two-week test-retest reliability of the CP-Q was examined using intraclass correlation coefficients (ICCs) to determine whether continuous values on the CP-Q ($M$ = 14.79 days between baseline and retest, $SD$ = 1.41) were stable over this time frame. ICC values were interpreted as follows: ≥ 0.75 were indicative of excellent reliability; 0.60–0.74 indicated good reliability; 0.40–0.59 indicated fair reliability; and < 0.40 were indicative of poor reliability (Fleiss et al., 2013). We also examined agreement on reported breakfast skipping and largest meal as measured by the CP-Q over the test-retest period. Additional estimates of internal consistency were not calculated because the individual items need not be inter-correlated to demonstrate reliability or validity.

Prior to recruitment, power analyses were conducted to determine appropriate sample size. Sample size recommendations were conducted for each proposed analysis using G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). Estimates for hierarchical regression yielded the largest total sample size, which thus served as the guideline for the present study's sample size. A sample size of at least 130 was required to detect a small to medium effect size (0.1), based on estimates of effect size described in Cohen (1988), at alpha of .05, power of .90.

## Results

Participants were primarily Caucasian, female, and in their freshman year, all of which are consistent with the demographic profile of undergraduate students in the North Dakota State University psychology department. Participants' ages ranged from 18 to 31 years ($M$ = 19.33, $SD$ = 1.70). See Table 2 for detailed demographic information of participants.

Statistical analyses were conducted to examine the characteristics of the CP-Q, and to evaluate convergent validity and test-retest reliability. Initial descriptive analyses suggested

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that all continuous variables were normally distributed, skewness and kurtosis were within acceptable ranges, a broad range of values were reported, and only a few instances of missing and impossible values were reported (see Table 3). Descriptive statistics for calculated chrononutrition behaviors are shown in Table 4. Further, analyses indicated that no significant differences in calculated ASA24 values existed between individuals who completed the ASA24 on only workdays, on only free days, and on both workdays and free days (all $p$'s > .05). We did evaluate the association between weekly averaged chrononutrition variables as assessed by the CP-Q (i.e., breakfast skipping, evening latency, evening eating, eating window) and BMI and general health as assessed by the SF-36 general health subscale. Pearson product moment correlations revealed that evening latency was significantly associated with BMI ($r$ = .19, $p$ = .025), but other chrononutrition behaviors were not significantly associated with BMI (all $p$'s > .05). None of the above CP-Q chrononutrition behaviors were significantly associated with general health (all $p$'s > .05).

## Convergent Validity

General chrononutrition behaviors measured by the CP-Q were validated by comparisons to aggregated information from study assessments.

We examined the level of agreement between weekly average evening latency, evening eating, and eating window as assessed by the CP-Q and the ASA24, and we found that roughly 43% of participants had no more than 60 minutes of disagreement on these chrononutrition behaviors between the two reports (see Table 5 for the percentage of the sample within ranges of agreement). Additionally, paired samples t-tests showed that reported weekly average breakfast skipping, evening eating, and eating window did not significantly differ between the ASA24 and the CP-Q (all $p$'s > .05); however, there were significant differences between weekly average evening latency as reported in the ASA24 ($M$ = 284.81, $SD$ = 111.36) and the CP-Q ($M$ = 231.51, $SD$ = 96.94), $t(139) = 5.02$, $p < .001$.

Pearson's product-moment correlations between CP-Q- and ASA24-assessed behaviors (i.e. evening latency, evening eating, and eating window) ranged from moderate to strong associations (see Table 5). CP-Q-assessed breakfast skipping was strongly correlated with ASA24-assessed breakfast skipping ($r$ = .58, $p < .01$).

In the CP-Q, 7 participants (4.8%) reported breakfast as their largest meal, 34 (23.3%) reported lunch as their largest meal, 100 (68.5%) individuals reported dinner/supper as their largest meal, and 2 (2.1%) reported "Another meal" as their largest meal. Three participants (2.1%) did not provide a response for the largest meal question. Comparisons of participants' reported largest meal between the CP-Q and the ASA24 indicated that 44 participants (30.1%) matched in their reporting of the typical largest meal (Kappa = .012), indicating poor validity of the CP-Q in terms of indication of the largest meal. No meaningful trends existed in discrepancies between the typical largest meal as reported by the ASA24 and the CP-Q.

## Test-Retest Reliability

Using a two-way, mixed consistency model, intraclass correlation coefficients (ICCs) were calculated to determine test-retest reliability of the CP-Q over the test-retest period (see

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Table 6). The use of ICCs for determining test-retest reliability was based on established standards in the literature (Bartko, 1966; Bartko & Carpenter, 1976; Shrout & Fleiss, 1979). Reported chrononutrition preferences (e.g., wake time preference, preferred evening latency) were also correlated (see Table 6). Correlations for free day values ranged from poor (lunchtime) to excellent (first eating event), while correlations for workday values were all excellent. Correlations for preference items ranged were good. Weekly averages were also computed for evening eating, evening latency, and eating window; correlations ranged from fair to excellent. In addition, correlations between breakfast frequency were excellent, as was the after-dinner snack frequency. All coefficients were significant at the $p < .001$ level. Additional analyses indicated that 79 participants (54.1%) reported the same frequency of breakfast skipping over the test-retest period. We also found that 116 participants (79.5%) reported the same largest meal over the two timepoints. These test-retest reliability indicators were further confirmed with a series of paired samples t-tests (all $p$'s > .05), with the exception of after-dinner snack frequency ($t = 5.48$, $p < .001$) (Table 6).

## Discussion

The present study aimed to develop and evaluate the Chrononutrition Profile - Questionnaire: a novel measure which assesses 6 specific behavioral patterns likely to impact one's chrononutrition profile. These include: 1) breakfast skipping, 2) largest meal, 3) evening latency, 4) evening eating, 5) night eating, and 6) eating window. Overall, the present study has provided preliminary support for the C-Q, as the measure displayed convergent validity and test-retest reliability in the present sample.

Convergent validity analyses yielded significant and moderate correlations between the CP-Q and the ASA24. Since the CP-Q measures general patterns of chrononutrition, there is a greater likelihood of discrepancy between that and the ASA24, which measured eating behaviors on specific days. Convergent validity of the CP-Q is best demonstrated through direct comparison of reported values which show that despite modest correlations with the ASA24, the agreement between these measures is acceptable. This level of agreement is a trend seen in most self-report questionnaires of eating and sleep behaviors (e.g., Girschik, Fritschi, Heyworth, & Waters, 2012; Kye et al., 2014) and indicates a need for further testing of the measure in older and general community samples.

A few aspects should be noted regarding test-retest-reliability of the CP-Q: 1) free day values were slightly less strongly correlated compared to workday values, and 2) the coefficient for lunchtime on free days was particularly low compared to the other items. This could indicate that overall, chrononutrition on free days may be more variable over time than chrononutrition on workdays, and lunchtime in particular may vary more on free days compared to the timing of other eating events. Chrononutrition preferences were also strongly correlated over the testing period. Though we did not account for seasonal variation in circadian patterns of eating or sleeping, data were collected rapidly with all recruitment completed within three months and within approximately the same season (February to April). Finally, secondary analyses identified one additional item (after dinner snack frequency) with potentially weaker test-retest reliability. As such, the primarily fair to

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excellent ICCs and paired samples t-tests indicate preliminary evidence for test-retest reliability of the CP-Q.

Two of the CP-Q's core chrononutrition behaviors in particular would benefit from further testing. The sample had a low prevalence of night eating which prevented evaluation of this component of the CP-Q; however, this construct is still of importance to chrononutrition more broadly and is highly relevant in some populations, such as persons with binge-eating (Striegel-Moore et al., 2010) and persons with diabetes (e.g., Abbott, Dindol, Tahrani, & Piya, 2018) and therefore was retained in the final version of the measure. In regards to reporting the largest meal, the present sample demonstrated questionable accuracy. This may be due to individuals' inability to accurately estimate their caloric intake. Evidence suggests, though, that the timing of the largest meal is relevant to body weight and health-related outcomes, and we chose to retain this construct in the final version of the measure. Although the present study was somewhat limited by its self-report assessments and the homogeneity of its sample (i.e., female, Caucasian), future research might target more diverse populations and methodology which could further our assessment of these and other chrononutrition behaviors. Because the present study provided a first step toward estimating the validity of the CP-Q, future work should continue to validate this measure, perhaps with different methodologies, such as ecological momentary assessment.

The CP-Q is a concise yet thorough measure of chrononutrition which can be used as a sole assessment of chrononutrition or as a supplement to existing dietary intake assessments. The ASA24 (Subar et al., 2012), for example, is quite burdensome for participants and may take as long as 30 minutes to complete each day. In addition, completion of the ASA24 requires internet access and may not be feasible for all populations (e.g., minority groups) (Ettienne-Gittens et al., 2013). Other existing dietary intake assessment methods also have limitations: for example, semi-structured interviews require interviewers to undergo considerable training, while findings from highly-controlled laboratory-based feeding assessments may not generalize to everyday life (for review, see Goldschmidt, 2017). The CP-Q, in contrast, can be completed in just a few minutes. This measure does not require internet access, accordingly reducing this potential barrier to data collection. In addition, the measure can be administered with little instruction and is designed to assess chrononutrition in a naturalistic setting.

This measure of the circadian timing of food intake may provide health care professionals, scientists, and stakeholders with a relatively simple and cost-effective assessment that can inform novel and effective prevention and treatment plans for diseases such as obesity, depression, and diabetes. The CP-Q be especially valuable in situations such as medical office visits when time is limited but a health care professional wants to assess general chrononutrition to determine potential areas for disease prevention or management. Researchers could also utilize the CP-Q to increase understanding of relationships between chrononutrition preferences and behaviors, and to evaluate the role of chrononutrition preferences in health decision-making (e.g., alcohol use).

The assessment of when individuals *prefer* to eat may provide a novel strategy for the creation of targeted health promotion and intervention efforts. Knowledge of chrononutrition

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preferences may be invaluable as this could provide insight into an individual's likelihood to adhere to chrononutrition behavior changes. For instance, an individual who prefers to wake up at 8:00AM and eat 30 minutes later could have difficulty adhering to an eating schedule in which the first eating event occurs at 10:00AM. Further, the CP-Q can be used to calculate eating misalignment (i.e., discrepancies between chrononutrition preferences and chrononutrition behaviors). It is possible that this may be an indicator of circadian misalignment (i.e., difference between timing on work versus free days (Wittmann et al., 2006), which could be examined in future research. For instance, recent research has acknowledged that preferred timing may serve as a measure of biological time for circadian misalignment (Groß et al., 2017; Jankowski, 2017).

In sum, a growing body of literature has suggested that *when* food intake occurs may also play a role in markers of health in addition to *what* and *how much* is consumed, though a comprehensive, reliable and valid measure of chrononutrition had not yet been developed. The present study developed and provided preliminary support for the CP-Q, a brief but thorough assessment of chrononutrition. The CP-Q can be applied in various research and clinical settings, and it will provide health behavior researchers and health care professionals with novel assessment method that will serve as a valuable addition to the existing literature.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Appendix A

## Chrononutrition Profile – Questionnaire (CP-Q)

### Directions:

The following questions are designed to assess the general timing of your eating. Please choose the one response that best fits your typical behavior and preferences.

**The term "eating event" refers to any time you eat something that contains calories. For example, this could be a meal, a snack, or a drink.—**If you were entirely free to plan your day,

**A1.** What time would you prefer to wake up? Please indicate A.M. or P.M. as part of your response.

_____ A.M./ P.M.

**A2.** How soon after waking up would you prefer to have your first eating event of the day?

_____ hours _____ minutes

**A3.** How soon before bed would you prefer to stop eating?

_____ hours _____ minutes

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**A4.** What time would you prefer to fall asleep? Please indicate A.M. or P.M. as part of your response.

_____ A.M./ P.M.

On average, in a typical week (a 7-day period),

**B1.** How often do you eat breakfast?

_____ 0 days

_____ 1 day

_____ 2 days

_____ 3 days

_____ 4 days

_____ 5 days

_____ 6 days

_____ 7 days

**B2.** What is your largest meal of the day?

_____ Breakfast

_____ Lunch

_____ Dinner/Supper

_____ Other meal (Please describe: _____)

**B3.** How often do you eat a snack after your last meal of the day?

_____ 0 days

_____ 1 day

_____ 2 days

_____ 3 days

_____ 4 days

_____ 5 days

_____ 6 days

_____ 7 days

**B4.** How often do you wake up in the night to eat?

_____ 0 days

_____ 1 day

_____ 2 days

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_____ 3 days

_____ 4 days

_____ 5 days

_____ 6 days

_____ 7 days

On average, on a typical workday or school day,

**C1.** What time do you wake up? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

**C2.** What time is your first eating event of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

**C3.** What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select “I do not eat lunch” if you do not typically eat lunch.

_____ A.M./ P.M.

_____ I do not eat lunch.

**C4.** What time is your last eating event before bed? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

**C5.** What time do you fall asleep? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

On average, on a typical weekend day or free day,

**D1.** What time do you wake up? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

**D2.** What time is your first eating event of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

**D3.** What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select “I do not eat lunch” if you do not typically eat lunch.

_____ A.M./ P.M.

_____ I do not eat lunch.

**D4.** What time is your last eating event of the day before bed? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

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**D5.** What time do you fall asleep? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

# Appendix B

## Chrononutrition Profile - Questionnaire (CP-Q) Scoring Guide

### Overview

The CP-Q provides scores on each of the 6 chrononutrition behaviors. Briefly, continuous values are calculated and/or extracted for each chrononutrition behavior (i.e., breakfast skipping, largest meal, evening eating, evening latency, night eating, eating window). Because the CP-Q measures behaviors for workdays and free days separately, additional calculations are required to provide a weighted aggregate score that better represents weekly patterns. Specifically, values are calculated separately for workdays and free days, then values are weighted to represent 5 workdays and 2 free days. For example, if the workday eating window is calculated as 10 hours and the free day eating window is calculated as 14 hours, the aggregate eating window is estimated as 11.14 hours (((10 hours * 5 days) + (14 hours * 2 days))/7 days). Alternatively, researchers could choose to keep workday and free day calculations separate and/or examine the discrepancy between them. However, the primary purpose of the CP-Q is to identify overall chrononutrition patterns, so we recommend the weighted aggregate score.

Though the continuous values represent the primary measures of the CP-Q, additional items were included to provide further options for data collection and analysis. For example, one can also calculate the time between eating events, the nighttime fasting period, eating midpoint, total sleep time, and sleep midpoint. The CP-Q includes questions about chrononutrition preferences, which allows for estimation of discrepancy between preferred and actual chrononutrition patterns as measured by the CP-Q. Preference items in the CP-Q are modeled after those in the Composite Scale of Morningness (CSM; Smith, Reilly, & Midkiff, 1989). Moreover, the CP-Q allows one to calculate desynchrony between workday and free day values.

**Chrononutrition Profile – Questionnaire—**Intended to assess general chrononutrition preferences and behaviors on a typical day

**Chrononutrition Preference Items**: aspects of when participant *prefers* to wake up, eat, and fall asleep

**A1:** Preferred wake time

**A2:** Preferred first eating event time

**A3:** Preferred last eating event time

**A4:** Preferred fall asleep time

Chrononutrition Preference Calculations:

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**A1 – A4:** Preferred sleep duration

**A3 – A2:** Preferred eating window

**Eating Misalignment Calculations:** The CP-Q can be used to evaluate eating misalignment, i.e., discrepancies between when people *prefer* to eat and when participants *actually* eat. Discrepancies can be calculated by using the chrononutrition behavior values for the item of interest. These are then subtracted from the preference value as measured by the CP-Q.

**a.** Sleep duration misalignment = Preferred sleep duration - Actual sleep duration

**b.** Sleep midpoint misalignment = Preferred sleep midpoint – Actual sleep midpoint

**c.** Eating window misalignment = Preferred eating window - Actual eating window

**d.** Eating midpoint misalignment = Preferred eating midpoint - Actual eating midpoint

**e.** Morning latency misalignment = Preferred morning latency - Actual morning latency

**f.** Evening latency misalignment = Preferred evening latency - Actual evening latency

**Chrononutrition Behavior Items:** aspects of when participant *actually* wakes up, eats, and falls asleep

### Workdays

**C1:** Wake time

**C2:** First eating event time

**C3:** Lunchtime

**C4:** Last eating event before bedtime

**C5:** Fall asleep time

### Free Days

**D1:** Wake time

**D2:** First eating event time

**D3:** Lunchtime

**D4:** Last eating event time

**D5:** Bedtime

### Frequencies (Days/Week)

**B1:** Breakfast eating

**B2:** Largest meal

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**B3:** Snacking after last meal

**B4:** Night eating

### Chrononutrition Behavior Calculations:

### Workdays:

**a.** Sleep duration = C1 – C5

  **a.** Duration of time between fall asleep time and wake time

**b.** Sleep midpoint = C5 + (Sleep duration/2)

  **a.** Time at the halfway point between fall asleep time and wake time

**a.** Last eating event = evening eating

  **a.** Eating late in the waking day

**b.** Eating window = C4 – C2

  **a.** Duration of time between first and last eating event of the day

**c.** Morning latency = C2 – C1

  **a.** Duration of time between wake time and first eating event

**d.** Lunch latency = C3 – C2

  **a.** Duration of time between lunch and first eating event

**e.** Afternoon latency = C4 – C3

  **a.** Duration of time between last eating event and lunch

**f.** Evening latency = C5 – C4

  **a.** Duration of time between last eating event and sleep onset time

### Free Days:

**a.** Sleep duration = D1 – D5

  **a.** Duration of time between fall asleep time and wake time

**b.** Sleep midpoint = D5 + (Sleep duration/2)

  **a.** Time at the halfway point between fall asleep time and wake time

**a.** Eating window = D4 – D2

  **a.** Duration of time between first and last eating event of the day

**b.** Morning latency = D2 – D1

  **a.** Duration of time between wake time and first eating event

**c.** Lunch latency = D3 – D2

  **a.** Duration of time between lunch and first eating event

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**d.** Afternoon latency = D4 – D3

**a.** Duration of time between last eating event and lunch)

**e.** Evening latency = D5 – D4

**a.** Duration of time between last eating event and sleep onset time

### Weekly Average: (((Workday value * 5) + (Free day value * 2))/7)

**a.** Example: ((10 hour workday eating window * 5) + (12 hour free day eating window * 2)/7)

= ((50)+(24)/7)

= ((74)/7)

= 10.57 hour weekly average eating window

### Frequency variables:

**a.** Breakfast skipping = Reverse score B1

**a.** Days per week in which breakfast is eaten => Days per week in which breakfast is skipped

0 days => 7 days

1 day => 6 days

2 days => 5 days

3 days => 4 days

4 days => 3 days

5 days => 2 days

6 days => 1 day

7 days => 0 days

**b.** Days per week in which breakfast is not eaten

**b.** Largest meal = B2

**a.** Meal in which largest amount of calories are consumed

**c.** Nighttime snacking = B3

**a.** Days per week in which participant has a snack after last meal

**d.** Night eating = B4

**a.** Days per week in which participant wakes up in the night to eat

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**Table 1.**

Summary of Literature on Chrononutrition Behaviors.

| Chrononutrition Behavior | Definition | Format | Reference | Sample | Summary of Findings |
|---|---|---|---|---|---|
| Breakfast skipping | Frequency with which an individual does not consume breakfast | Days Per Week | Ma et al. (2003) | U.S. adults | Skipping breakfast was related to 4.5 times greater likelihood of obesity |
| | | | Smith et al. (2010) | Australian children who completed a follow-up in adulthood | Children who skipped breakfast in both childhood and adulthood had greater waist circumference, higher total cholesterol and LDL cholesterol concentrations than individuals who ate breakfast in childhood and adulthood |
| | | | Brown et al. (2013) | Meta-analysis | Skipping breakfast was associated with obesity |
| | | | Kant & Graubard (2015) | U.S. adults | Skipping breakfast was linked to consumption of earlier and more energy-dense lunches |
| | | | Thomas et al. (2015) | U.S. women with BMI 27–35 $kg/m^2$ | Habitual breakfast eaters may be more negatively impacted by skipping breakfast than habitual breakfast skippers |
| | | | Witbracht et al. (2015) | U.S. women aged 18–45 with BMI < 40 $kg/m^2$ | Skipping breakfast 5 or more days/week was associated with abnormal cortisol rhythms and increased blood pressure |
| | | | Lee et al. (2016) | Japanese adults | Skipping breakfast 3 or more days/week was not associated with overweight BMI (> 25.0 $kg/m^2$) |
| Largest meal | Meal in which the largest amount of calories is consumed | Name of meal (i.e., breakfast, lunch, dinner/ supper) | Garaulet et al. (2013) | Spanish adults beginning a behavioral weight loss program | Adults who ate the main meal (i.e., lunch) late lost less weight and lost weight at a slower rate compared to those who ate the main meal early, though energy intake and diet composition were similar between early and late eaters |
| | | | Jakubowicz et al. (2013) | Overweight and obese women with metabolic syndrome | Women who ate a high-calorie breakfast and low-calorie dinner lost more weight and had a greater reduction in waist circumference, fasting glucose, and insulin than women who ate a high-calorie dinner and low-calorie breakfast |
| | | | Kahleova et al. (2017) | Members of Seventh-day Adventist churches in the U.S. and Canada ≥ 30 years old | Individuals who consumed breakfast as their largest meal had lower BMI over time compared to those who had their largest meal at lunch or dinner |
| Evening eating | Eating late in the waking day | Clock Time (HH:MM) | Dattilo et al. (2010) | Healthy adults aged 19–45 | Fat intake at night was associated with higher body fat percentage, higher BMI, and greater waist circumference in men |
| | | | Baron et al. (2011) | U.S. adults | Calorie consumption after 8:00 PM predicted BMI after controlling for sleep timing and sleep duration |
| | | | Yoshizaki et al., (2013) | Men who habitually skipped breakfast | Participants in the early meal schedule (meals at 8:00, 1:00 PM, and 6:00 PM) had lower triglyceride and total and LDL cholesterol levels than did participants in the control group (meals at 1:00 PM, 6:00 PM, and 11:00 PM) after 2 weeks |
| | | | Reid et al. (2014) | U.S. adults | Eating the last meal later in the evening was associated with greater calorie intake |

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| Chrononutrition Behavior | Definition | Format | Reference | Sample | Summary of Findings |
|---|---|---|---|---|---|
| | | | Lee et al. (2016) | Japanese adults | Eating late in the evening was not associated with overweight BMI (> 25.0 kg/m$^2$) |
| | | | Fong et al. (2017) | Meta-analysis | BMI was not associated with evening food intake |
| | | | McHill et al. (2017) | Adults aged 18–22 | Individuals with higher body fat had a later last eating event later than leaner individuals did |
| Evening latency | Duration of time between last eating event and sleep onset | Minutes | Piesman et al. (2007) | Patients with gastroesophageal reflux disease | Food intake within 2 hours of bed, but not within 6 hours of bed, was associated with increased acid reflux symptoms |
| | | | Reid et al. (2014) | U.S. adults | A shorter evening latency was linked to greater calorie intake |
| Night eating | Waking in the night to eat; one element of NES | Days Per Week | O'Reardon et al. (2004) | Overweight/obese U.S. adults with NES and matched controls | Total energy intake did not differ between NES and control participants, but NES participants seemed to have a phase delay in food intake |
| | | | Colles et al., (2007) | Bariatric surgery candidates, members of a non-surgical weight loss support group, and community members | NES was positively associated with BMI; those with NES who consumed nighttime snacks had lower mental health-related quality of life, greater depressive symptoms, and greater hunger than those with only NES |
| | | | Gluck et al. (2008) | Healthy nondiabetic Pima Indians and Caucasian adults in the U.S. | Individuals who engaged in night eating (eating between 11:00PM and 5:00AM) had greater weight gain than individuals who were not night eaters |
| Eating window | Duration of time between the first eating event and the last eating event of the day | Minutes | Arble et al. (2009) | Male Mice | Mice fed a high fat diet during the typical rest phase gained more weight than mice fed the same diet during the typical active phase; calorie intake was identical across study conditions |
| | | | Hatori et al. (2012) | Male Mice | Though calorie intake was equivalent, mice with *ad libitum* access to a high fat diet gained 28% more weight and were at increased risk of obesity and comorbidities compared to mice with an eating window of 8 h/day |
| | | | Chaix et al. (2014) | Male Mice | A restricted eating window protected against the negative effects of a high-fat and high-sugar diet, although calorie intake was equivalent to that of mice fed normal chow |
| | | | Gill & Panda (2015) | Overweight, healthy U.S. adults with eating window > 14h/day | Individuals who restricted their eating window to 10–12 h/day for 36 weeks lost weight, reported greater sleep satisfaction and energy; restriction of eating window led to decreased calorie intake |

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**Table 2.**

Sample demographics (N = 146).

| Demographic Variable | N (%) |
|---|---|
| Gender | |
| Male | 29 (19.86) |
| Female | 117 (80.14) |
| Race | |
| Asian | 7 (4.79) |
| African American | 9 (6.16) |
| White | 123 (84.25) |
| Other/Mixed | 7 (4.79) |

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**Table 3.**

Initial descriptive statistics of Chrononutrition Profile-Questionnaire items (N = 146).

| CP-Q Item | Range | Mean | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|
| Wake Time - FREE | 5:00 – 13:00 | 9:53 | 1:17 | −0.56 | 0.64 |
| Wake Time - WKDY | 4:20 – 11:00 | 8:05 | 1:07 | −0.51 | 0.61 |
| Wake Time - PREF | 5:00 – 13:00 | 9:22 | 1:11 | −0.43 | 1.50 |
| First Eating Event - FREE | 7:15 – 16:00 | 11:13 | 1:28 | −0.11 | 0.23 |
| First Eating Event - WKDY | 4:45 – 18:00 | 10:05 | 1:57 | 0.53 | 1.35 |
| **Morning Latency - PREF** | **10.00 – 270.00** | **59.52** | **43.42** | **2.31** | **6.88** |
| Lunchtime - WKND | 11:00 – 17:00 | 12:56 | 1:04 | 0.80 | 0.71 |
| Lunchtime - WKDY | 11:00 – 16:00 | 12:34 | 0:58 | 0.67 | 0.58 |
| Last Eating Event - FREE | 17:00 – 2:00 | 20:46 | 1:55 | 0.29 | −0.46 |
| Last Eating Event - WKDY | 17:00 – 2:00 | 19:59 | 1:46 | 0.44 | 0.03 |
| Evening Latency - PREF | 10.00 – 300.00 | 138.46 | 68.75 | 0.39 | −0.38 |
| Bedtime - FREE | 21:00 – 3:00 | 24:45 | 1:14 | −0.10 | −0.11 |
| Bedtime - WKDY | 21:00 – 3:00 | 23:46 | 1:06 | 0.13 | 0.11 |
| Bedtime - PREF | 21:00 – 3.00 | 23:14 | 1:05 | 1.08 | 1.97 |
| Breakfast Consumption | 0.00 – 7.00 | 4.08 | 2.41 | −0.31 | −1.21 |

*Note*. FREE = free day; WKDY = workday; PREF = preference.

*Note*. Bolded rows indicate items with skewness and kurtosis.

*Note*. Analyses were based on all available data due to missing items; actual sample sizes ranged from N = 144 to N = 146.

*Note*. Wake time, bedtime, first eating event, lunchtime, last eating event, evening eating represented as HH:MM, morning latency, evening latency, and eating window expressed in minutes, and breakfast consumption expressed as number of days per week.

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**Table 4.**

Descriptive statistics of calculated Chrononutrition Profile-Questionnaire and ASA24 variables (N = 146).

| Chrononutrition Behavior | Range | Mean | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|
| CP-Q | | | | | |
| Breakfast Skipping | 0.00 – 100.00 | 41.77 | 0.34 | 0.31 | −1.21 |
| Evening Eating | 15:00 – 2:00 | 19:56 | 1:46 | 0.28 | 0.42 |
| Evening Latency | 30.00 – 450.00 | 229.91 | 97.21 | 0.12 | −0.49 |
| Eating Window | 300.00 – 915.00 | 590.91 | 138.48 | 0.05 | −0.48 |
| ASA24 | | | | | |
| Breakfast Skipping | 0.00 – 100.00 | 37.00 | 0.39 | 0.49 | −1.31 |
| Evening Eating | 12:13 – 22:57 | 19:34 | 1:44 | −0.84 | 1.63 |
| Evening Latency | 30.00 – 635.00 | 284.70 | 110.97 | 0.56 | .39 |
| Eating Window | 274.29–865.00 | 561.71 | 131.38 | 0.07 | −0.42 |

*Note*. CP-Q = Chrononutrition Profile – Questionnaire; ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool.

*Note*. Breakfast skipping represented as percent of days per week, evening eating represented as HH:MM, evening latency and eating window expressed as minutes.

*Note*. Analyses were based on all available data due to missing items; actual sample sizes ranged from N = 136 to N = 146.

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**Table 5.**

Agreement between Chrononutrition Profile-Questionnaire and ASA24-assessed chrononutrition behaviors (N = 146).

| Chrononutrition Behavior | | % of Sample Within Range of Agreement | | | | | M (*SD*) | Correlation (Pearson's *r*) with Corresponding ASA24 Variable |
|---|---|---|---|---|---|---|---|---|
| | | < −120 minutes | −120 to −61 minutes | −60 to 60 minutes | 61 to 120 minutes | > 120 minutes | | |
| CP-Q | Evening Latency | 24.3 | 20.0 | 38.6 | 10.0 | 7.1 | 229.91 minutes (*97.21*) | .28** |
| | Evening Eating | 9.8 | 11.9 | 48.3 | 11.2 | 18.9 | 19:56 (*1:46*) | .29** |
| | Eating Window | 12.9 | 9.8 | 42.4 | 10.6 | 24.2 | 590.91 (*138.48*) | .44** |

*Note*. CP-Q = Chrononutrition Profile – Questionnaire.

*Note*. ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool.

*Note*. Evening eating represented as HH:MM, evening latency and eating window expressed as minutes.

*Note*. Analyses were based on all available data due to missing items; actual sample sizes ranged from N = 134 to N = 146.

Note.

** = significant at the .01 level.

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**Table 6.**

Intraclass correlation coefficients and means of paired samples t-tests for two-week test-retest reliability for the Chrononutrition Profile-Questionnaire (N = 146).

| Item | Intraclass Correlation Coefficient | Paired Samples T-Test | |
|---|---|---|---|
| | | Mean (SD) at Initial Test | Mean (SD) at Retest |
| Chrononutrition Preferences | | | |
| Morning Latency | .73*** | 59.52 (43.41) | 56.78 (36.74) |
| Evening Latency | .64*** | 138.46 (68.75) | 142.64 (72.84) |
| Chrononutrition Behaviors – Free Days | | | |
| First Eating Event | .77*** | 11:13 (1:28) | 11:12 (1:31) |
| Lunchtime[a] | .39*** | 12:50 (1:34) | 12:59 (1:06) |
| Last Eating Event | .71*** | 20:46 (1:55) | 20:37 (1:52) |
| Chrononutrition Behaviors - Workdays | | | |
| First Eating Event | .85*** | 10:05 (1:57) | 10:03 (1:52) |
| Lunchtime[b] | .77*** | 12:34 (0:58) | 12:31 (0:57) |
| Last Eating Event | .75*** | 19:59 (1:46) | 19:56 (1:42) |
| Computed Weekly Averages | | | |
| Breakfast Frequency | .88*** | 4.06 (2.41) | 4.04 (2.30) |
| Evening Eating | .51*** | 19:51 (2:01) | 19:45 (1:46) |
| After-Dinner Snack Frequency | .75*** | 3.97 (1.96)*** | 3.34 (1.97)*** |
| Evening Latency | .74*** | 230.8 (94.41) | 234.75 (102.53) |
| Eating Window | .79*** | 588.13 (130.09) | 586.18 (126.40) |

[a]Analysis based on sample size of n = 123 due to remaining individuals reporting “I do not eat lunch”.

[b]Analysis based on sample size of n = 139 due to remaining individuals reporting “I do not eat lunch”.

*Note*. Analyses were based on all available data due to missing items; actual sample sizes ranged from N = 144 to n = 146.

*Note*. Means for first eating event, lunchtime, last eating event, evening eating represented as HH:MM; means for morning latency, evening latency, and eating window expressed in minutes; and means for breakfast frequency, and after-dinner snack frequency expressed as number of days per week.

Note.

*** = significant at the $p < .001$ level.

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